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Abstract

The scanning electron microscope has been used to observe the digestion of alfalfa hay and warm- and cool-season grasses. Photomicrographs show that leaves of all species are digested by bacteria and protozoa attacking either the upper part of the leaf or exposed edges; lower leaf surfaces are never attacked. Intake of a forage depends on how rapidly rumen bacteria and protozoa can enter the upper leaf surface and digest underlying material (mesophyll) leaving most of the highly lignified nutrient-carrying vessels (vascular tissue) undigested.

Keywords

Report of progress (Kansas State University. Agricultural Experiment Station); 291; Cattlemen's Day, 1977; Beef; Intake; Alfalfa hay; Forage

A New Tool For Evaluating forages

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Summary

The scanning electron microscope has been used to observe the digestion of alfalfa hay and warm- and cool-season grasses. Photomicrographs show that leaves of all species are digested by bacteria and protozoa attacking either the upper part of the leaf or exposed edges; lower leaf surfaces are never attacked. Intake of a forage depends on how rapidly rumen bacteria and protozoa can enter the upper leaf surface and digest underlying material (mesophyll) leaving most of the highly lignified nutrient-carrying vessels (vascular tissue) undigested.

Introduction

A new type of microscope, purchased by the Kansas Agriculture Experiment Station and supervised and directed by Dr. C. W. Pitts, Entomology, scans the surface of material with an electron beam so that three dimensional images can be obtained at high magnifications. It helps scientists study such diverse agricultural materials as insects, soils, plants, grains, pollen, bacteria, and animal tissues.

Over the past several years, using this microscope, we have been able to study the digestion of grains and forages. The photomicrographs presented here show how alfalfa hay (leaves and stems) and leaves of cool-season grasses (brome and fescue) and leaves of warm-season grasses (big and little bluestem) are digested.

Materials and Methods

Leaves and stems were collected and frozen in liquid nitrogen to keep all structures intact. They were put into nylon bags and digested in rumen fistulated steers for various times. They were then preserved, dried, and mounted for observation under the scanning electron microscope (SEM).

Results and Discussion

Leaves of alfalfa hay (figure 14.1a) are rapidly digested by rumen bacteria as shown in figure 14.1b. The upper surface (cuticle) is rapidly and randomly sloughed, and underlying tissue is digested by 24 hours leaving only lower cuticle and its hair.

Alfalfa stems (figure 14.2a) are rapidly digested by sloughing of the outer surface and breakdown of the dense layer beneath. Further digestion of the stem is slight (figure 14.2b).

Brome and fescue are digested more slowly than alfalfa leaves, as in figure 14.3. Approximately 90% of the upper surface of brome is attacked by bacteria. It appears that silica or cutin or both limit digestion to 50% of the upper surface of fescue (K-31) so it takes longer than brome to reach and digest underlying material. Vascular tissue is not attacked in either grass so the amount of vascular tissue and structural inhibitors in the upper surface influence intake and rate of digestion even though chemical analyses may be similar.

Further inhibition by silica bodies and cutin are shown by the slow penetration of bacteria and protozoa into bluestem (figure 14.4).

The SEM studies show that chemical analyses and digestibility cannot always accurately explain differences in utilization of forages. The type of cutin and distribution of silica appear to be more important than the quantity of either. The amount of vascular tissue (major lignin component) in both grasses and legumes serves as an endpoint of digestion rather than an inhibitor of digestion.

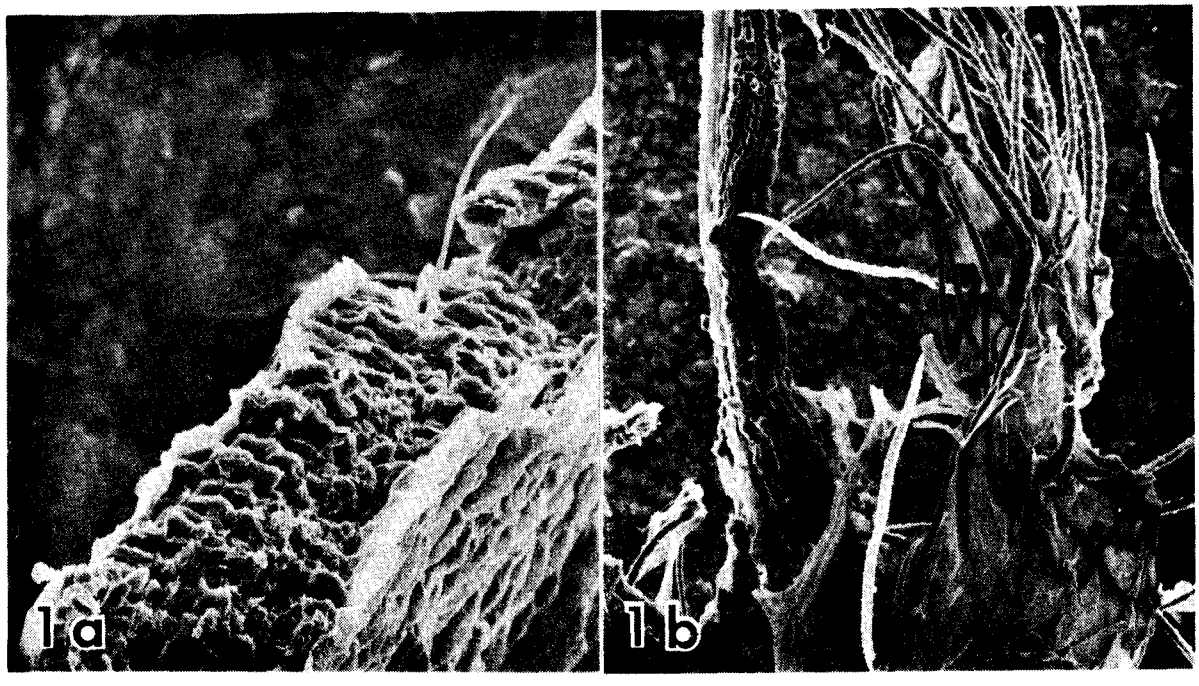

Figure 14.1 Alfalfa leaf. a) Cross-section of alfalfa leaf before being digested. b) Remains of alfalfa leaf after 24 hours' digestion shows upper cuticle (left) and lower cuticle with hair.

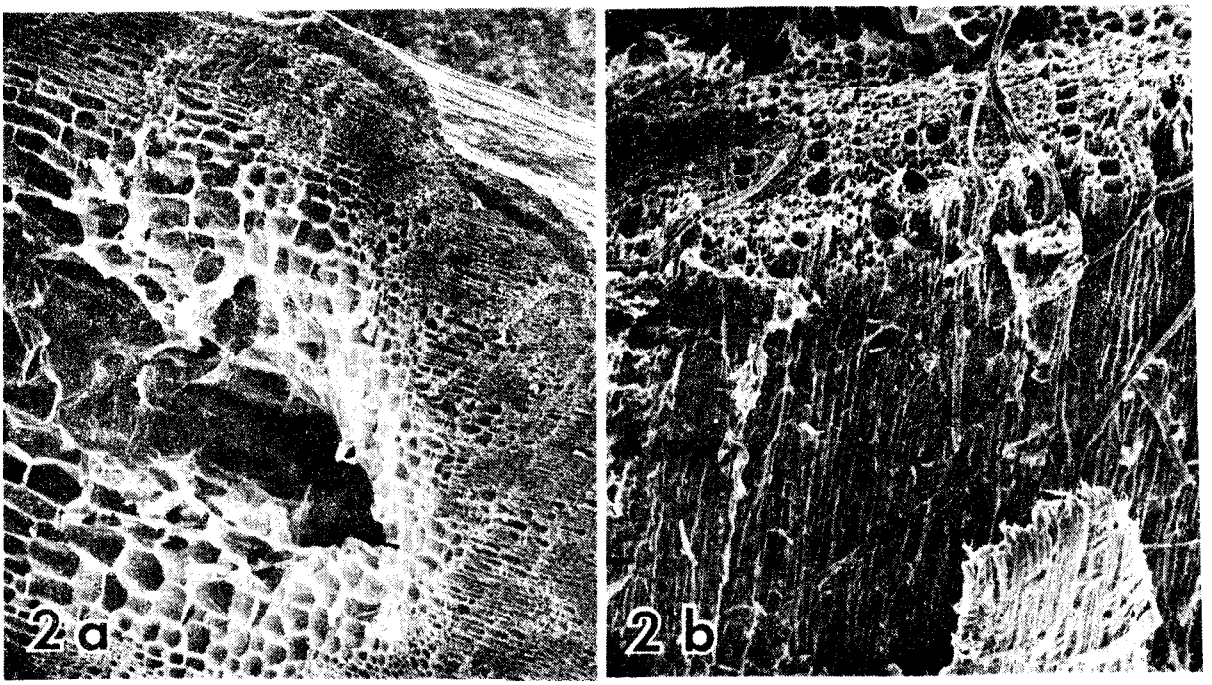

Figure 14.2 Alfalfa stems. a) Cross-section of alfalfa stem before being digested. b) Cross-section after 48 hours.

Figure 14.3 Digestion of fescue after 48 hours in the rumen.

Figure 14.4 Digestion of big bluestem.